

# $\omega$ and $\eta$ meson production in p+p reactions at $E_{kin} = 3.5$ GeV

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## Abstract

We report on the exclusive production of  $\omega$  and  $\eta$  mesons in  $p + p$  reactions at 3.5 GeV beam kinetic energy. Production cross sections, angular distributions and Dalitz plots of both mesons were determined. Moreover, the relative contribution of the  $N(1535)$  resonance in  $\eta$  production at this energy was evaluated.

We conclude that  $\eta$  mesons produced via  $N(1535)$  exhibit an isotropic angular distribution, whereas those produced directly show a strong anisotropic distribution.  $\omega$  mesons show a slightly anisotropic angular distribution.

*Keywords:*  $\omega$ ;  $\eta$ ; meson production; proton-proton collisions

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## 1 Introduction and Motivation

The determination of integrated and differential cross sections for the production of light mesons in the energy range up to 1 GeV above threshold in proton-proton reactions is very important for the understanding of the underlying elementary mechanisms as well as for the interpretation of heavy ion results. However, most of the high-precision and high-statistics experiments were performed near threshold. At higher energies, a large number of older data sets are available but only for integrated cross sections[1].

Concerning the  $\eta$  production at such energies, the DISTO collaboration provided a comprehensive set of measurements, including momentum and angular distributions as well as  $pp\eta$  Dalitz plots, all at three different beam energies (2.15, 2.5 and 2.85 GeV)[2]. However, the provided angular distributions were integrated over the whole Dalitz plot.

Moreover, the DISTO collaboration studied the angular distribution of  $\omega$  mesons in  $p + p$  reactions at 2.85 GeV beam kinetic energy[3].

In this work, we present new measurements of integrated and differential cross sections for the production of  $\eta$  and  $\omega$  mesons in  $p + p$  reactions at 3.5 GeV beam kinetic energy using the magnetic spectrometer HADES[4] (**H**igh **A**cceptance **D**i-**E**lectron **S**pectrometer).

## 2 Analysis

The reconstruction of  $\omega$  and  $\eta$  mesons was done via their decay into three pions ( $\pi^+\pi^-\pi^0$ ). The two protons and charged pions were identified using energy loss information in the drift chambers. The  $\pi^0$  was reconstructed via the missing mass method. To improve the momentum resolution, a kinematical fit was applied. The background channels were removed by a cut on the probability of the fit. The  $\omega$  and  $\eta$  mesons can be clearly identified as two peaks on top of a continuous background in the two protons missing mass spectrum.

### 3 Results

#### 3.1 $\omega$ meson

For the  $\omega$  meson production, we present in fig. 1 the  $pp\omega$  Dalitz plot and polar angular distribution in the c.m. system. All plots were corrected for the detector acceptance bin-by-bin using a corresponding factor extracted from a PLUTO[5] + GEANT simulation.

We do not observe a strong contribution of resonances in the production and we find that the polar angular distribution of  $\omega$  mesons is only slightly anisotropic. The determined cross section amounts to  $(137 \pm 27) \mu\text{b}$  (prelim.).

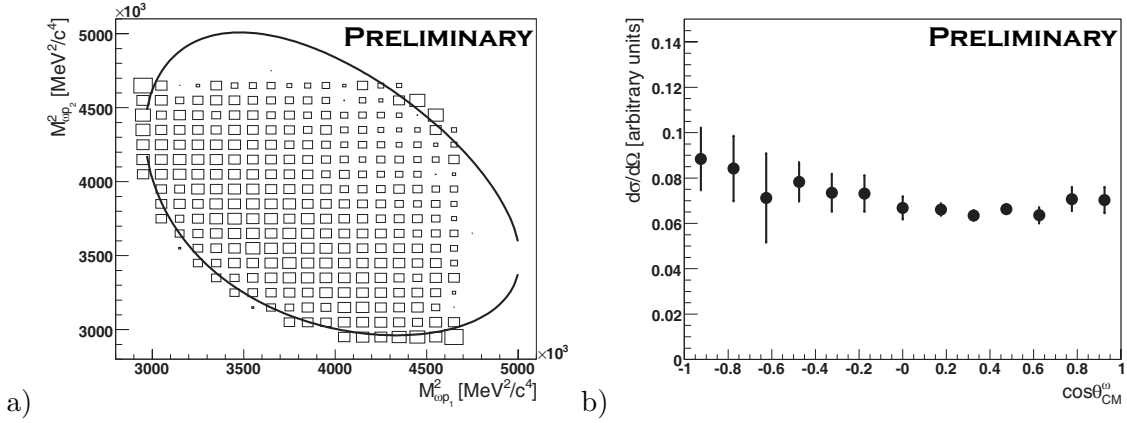


Figure 1: a)  $pp\omega$  Dalitz plot. The thick line shows the phase space limit. b) Polar angular distribution of  $\omega$  emission in the c.m. system. Both plots are corrected for acceptance. Empty bins correspond to zero acceptance.

#### 3.2 $\eta$ meson

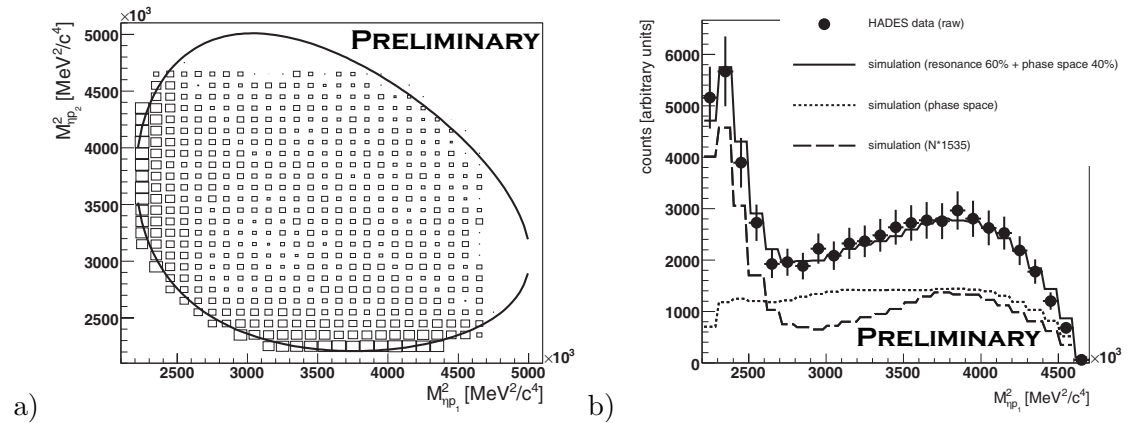


Figure 2: a)  $pp\eta$  Dalitz plot. The thick line shows the phase space limit. The data are corrected for acceptance. Empty bins correspond to zero acceptance. b) Projection of the raw Dalitz plot. The dotted line shows the mass distribution as given by phase space. The dashed line shows simulation of the mass distribution for production via  $N(1535)$ .

The  $pp\eta$  Dalitz plot (fig. 2a) shows a clear signal from the  $N(1535)$  resonance. To extract the relative contribution of the resonance to the production we simulated the  $p\eta$  mass distribution in two scenarios:

- a)  $\eta$  production according to phase space.
- b)  $\eta$  production via  $N(1535)$  resonance.

The resulting spectra were scaled to fit the measured data (see fig. 2b). The relative contribution of  $N(1535)$  to the production was determined to be about 41% (prelim.).

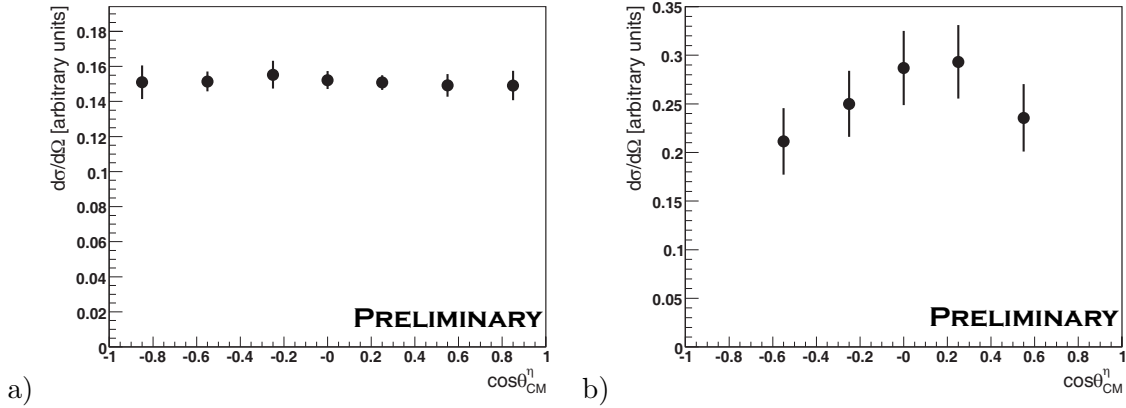


Figure 3: a) Polar angular distribution of  $\eta$  emission in the c.m. system (from resonance region). b) Polar angular distribution of  $\eta$  emission in the c.m. system (from non-resonant region). Both spectra are corrected for acceptance. Empty bins correspond to zero acceptance.

The angular distribution of  $\eta$  emission was determined for two regions of the Dalitz plot:

- I) the region where  $M_{\eta+p_1}^2$  or  $M_{\eta+p_2}^2 < 2.8 \text{ GeV}^2/c^4$ . The  $\eta$  production in this region is dominated by resonant production.
- II) the region where  $M_{\eta+p_1}^2$  and  $M_{\eta+p_2}^2 > 2.8 \text{ GeV}^2/c^4$ . The  $\eta$  production in this region is dominated by non-resonant production.

The angular distribution for region I is clearly flat as shown in fig. 3a, whereas that of region II is strongly anisotropic (fig. 3b). The total production cross section was determined to be  $(211 \pm 47) \mu\text{b}$  (prelim.).

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